SURFACE ROUGHENING IN ALUMINUM ALLOYS

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By its nature, plastic deformation of metallic polycrystals is spatially non-uniform and anisotropic on the size scale of the grain. The plastic deformation-induced roughening of initially smooth free surfaces is an outward manifestation of heterogeneous straining on this size scale. By their gross appearance, roughening features can be seen to be related to the underlying material microstructure. However, the nature of these links are subtle. For instance, from the appearance of post deformation features, we find that grains can appear to deform in clusters. Predicting deformation-induced roughening necessitates the quantification and representation of processes that exist over several size scales. This talk describes an experiment / simulation - based study focused on the deformation behavior of thick AA 7050 aluminum plate. As a means for understanding the behavior of think sections of the plate material, deformation-induced surface roughening of thin tensile specimens were examined. After quantifying the roughening features, it was found that the character of the roughening features varied with plate thickness, location within the plate and specimen orientation. Simulations of these experiments involved creating virtual specimens composed of finite element - discretized crystals, whose size, orientation and intragrain misorientations were chosen to match experimentally measured crystal distribution statistics. A continuum slip - polycrystal plasticity model was employed with hardening parameters determined by matching the macroscopic stress-strain response. The simulations matched various aspects of the observed roughening behavior including the width of the roughening features, the trends in roughening with specimen orientation, as well as the spatial variation of the roughening. However, the magnitude of the roughening features was less accurately captured, as the model over-predicted the height of the surface roughening. The successes and shortcomings of the simulations build additional insight into the complicated processes that underlie surface-roughening phenomenon in aluminum alloys.